the development of one species have been shortened? M. Giard communicates no observations which might prove the impossibility of such a shortening of the development. Consequently I maintain my view that the species described since by Dr. Russmann under the name of *Thompsonia globosa* (Verhandl. d. phys.-med. Gesellsch. zu Würzburg, 1872, oder Arbeiten aus dem zoologisch-zootomischen Institut zu Würzburg, Band i. p. 131), after my drawings and specimens, has larvæ which leave the egg only in the Cypridine form. There is even no stringent reason to take it for granted, as M. Giard not very judiciously seems to do, that they undergo a conspicuous change of form within the egg, although this, of course, remains to be ascertained.

Yours very truly,

Würzburg, November 20, 1874. Prof. C. Semper.

On the Circulatory Apparatus of the Echinida. By M. E. Perrier.

The circulatory apparatus of the Sea-Urchins has been the subject of numerous investigations, which are summarized in Valentin's monograph on *Echinus lividus*, and more recently in the fine monograph of the Echinida by Mr. Alexander Agassiz. These various researches have left very doubtful even the most important points in the arrangement of the vascular apparatus. We can regard as certain only these two facts :—1. The existence of an intestinal vascular apparatus. 2. The existence of a system of vessels communicating with the ambulacral canals, and usually designated by the name of the aquiferous apparatus. We did not even know whether these two systems of vessels were distinct, or whether they communicated with each other. This communication, imperfectly seen by Louis Agassiz, and since sought in vain by many anatomists, has only been met with again quite recently by Hoffmann in the *Spatangi* and *Toxopneustes*, belonging to the regular Echinida. But there were still many questions to be solved :—The mode of vascularization of the test indicated by some authors seemed very doubtful. The structure of the heart, or at least of the organ so called by anatomists, remained very obscure ; moreover there was occasion, in the presence of contradictory statements, to verify the announced results, to group and coordinate, and finally to present a complete and homogeneous description of the circulatory apparatus of the Echinida.

This is the problem which I have endeavoured to solve during a stay of several weeks at the laboratory of experimental zoology of M. de Lacaze-Duthiers at Roscoff (Finisterre).

The dredging-operations instituted by M. de Lacaze-Duthiers at his laboratory brought in every day with certainty a great number of specimens of *Echinus sphæra*, which, in consequence of their considerable size, were particularly well adapted for my investigations, the results of which may be summarized as follows :—

Beneath the madreporic plate a canal (the sand-canal) originates, which descends vertically towards the lantern, passing along the œsophagus to the left and behind. This vessel and the œsophagus are united by a mesenteric lamina which embraces the organ hitherto known

as the heart, to which the vertical canal is intimately united, but without having any relations to it except those of contiguity. The organ in question *is therefore not a heart*, as has hitherto been believed; and we shall recur immediately to its structure. Having arrived at the point where the œsophagus penetrates into the lantern, the vertical vessel opens into a circular vessel resting on the superior membranous floor of the lantern and bearing opposite to each of the pyramids a small racemiform gland (Poli's glands). This, whatever may have been said, is the only vascular ring presented by the circulatory apparatus of the Echinida; at least I have found it impossible to discover any other. From this ring, opposite to the intervals of the pyramids and consequently alternating with Poli's glands, spring five radiating vessels which pass beneath the calcareous piece known as the *falx*, and become widened so as to occupy the whole width of the inferior surface of this piece. Arriving at the outer margin of the lantern these radiating canals resume their original calibre and run along the outer surface of the lantern, from which, however, they finally separate, so that each of them may become continuous with one of the five ambulacral canals. The latter are produced a little towards the mouth beyond their point of junction with the five vertical canals; it is this, no doubt, that has led to the belief in the existence of a vascular ring applied to the buccal membrane within the lantern; but this ring has no existence: the prolongations of the ambulacral canals soon bifurcate; and each of their branches penetrates into one of the two large buccal tentacles.

The ambulacral canals ascend along the test, and *terminate cœcally* below the pore presented by the so-called *ocular* plates, although these do not contain any organ of vision. In *Echinus sphæra* this pore is closed by a continuous membrane, and does not give passage to any thing resembling an unpaired tentacle. Although one can inject the whole circulatory apparatus by applying to one of these pores the pipe of a syringe, there is not in it any direct communication between the vascular apparatus and the exterior; the injection only penetrates in consequence of a lesion. There is no anal ring uniting the five ambulacral vessels. Each canal is the seat of a double current maintained by the vibratile cilia which clothe its interior; it serves at once for the flow and the return of the sanguine liquid which it contains, as I have been able to ascertain by direct observation. The arrangement of the ambulacral vessels of the Echinida therefore exactly reproduces that which I have already described in the *Comatulæ*.

Immediately opposite to the right upper Poli's gland there springs from the circular vessel of the lantern a vascular branch which ascends along the œsophagus, and forms, to a certain extent, a pendant to the vertical canal which originates from the madreporic plate and opens at the left posterior Poli's gland. Having reached the point where the œsophagus opens into the intestine, this canal becomes reflexed and considerably widened, and constitutes the great vessel which follows the inner margin of the intestine, and beyond which the mesenteric plate is slightly prolonged. There is con-

sequently a real communication between the intestinal vascular apparatus and the supposed aquiferous apparatus. The inner vessel is separated from the intestine proper by the singular canal which I propose to name the *intestinal siphon*, which, originating from the upper extremity of the œsophagus, runs to open into the intestine a little before its point of reflexion, and which, according to certain observations, would seem to be destined for the rapid conveyance of sea-water into the second bend of the intestine. Beyond the point where this canal opens into the intestine, the vessel which accompanies it widens into a great reservoir, from which issue numerous vascular branches passing to the intestine. This reservoir is produced a little upon the reflected part of the mesentery; but it soon diminishes in volume, and becomes very rapidly resolved into a network of capillaries, which may be traced for a considerable distance upon the mesentery; the inner vessel therefore is not prolonged as a distinct vessel upon the second bend of the intestine.

All along its course the vessel which has just been described emits numerous branches which pass to the intestine and constitute the afferent branches of a very rich and elegant capillary network, the efferent branches of which pass to a trunk passing along the outer margin of the intestine, the external marginal trunk. This trunk is continued into the mesenteric plate; we have never seen it emitting even the smallest branch passing to the test. We do not see what return course could be taken by the blood which might get into these branches; and it is evident that the external and internal marginal vessels constitute the two principal trunks of an isolated intestinal vascular system, completed by the capillary network. This circle being thus closed there can be no question of branches opening towards the test, unless it be possible to close it again. The external marginal vessel is prolonged further upon the second bend than the internal vessel; but it also diminishes very rapidly and does not reach the anus. I have not been able to follow it to the ring of the lantern; the injection is always arrested at the origin of the œsophagus. Moreover, if this vessel were prolonged as far as the lantern, it would necessarily terminate at the same point as the vertical canal, which is not very probable.

In its festooned course along the first bend this vessel splits so as to form a thick, nearly circular trunk, which communicates with it by its two ends, one situated close to the stomach, the other close to the point of reflexion of the intestine. Six vertical branches, at nearly equal distances apart, also make a communication between the marginal vessel and this circular vessel, which floats freely in the liquid of the general cavity, and enjoys, like the marginal vessels, a very marked contractility, although this did not appear to be rhythmical.

The histological investigation of the supposed heart showed that this organ was nothing but a true gland, the product of which is poured into a tubular cavity situated below the vertical canal starting from the madreporic plate. This cavity is prolonged into an excretory duct, opening also at the infundibuliform space enclosed

between the membrane of the test and the madreporic plate. Other tubular glands, situated on the opposite side of the œsophagus, in the thickness of the mesentery itself, open in part with this excretory duct, and in part directly beneath the madreporic plate, the pores of which probably give issue to the secreted liquid. It is to be observed that, by the intermediation of the infundibuliform space situated below the madreporic plate, the circulatory apparatus and this glandular apparatus communicate with each other, so that an injection driven through the supposed heart may descend again through the sand-canal.

In the Spatangidæ (*Amphidetus*), which have been said to have no trace of a heart, I have found a gland exactly similar to that which hitherto has been regarded as the heart in the Echinida.

Lastly, I have ascertained, by varied experiments, that the water which fills the cavity of the test of the sea-urchins can only penetrate them slowly and by endosmose, either through the buccal membrane or through the ambulacral tubes. When sea-urchins have lived for some time in sea-water coloured with aniline, we very regularly find the entire œsophagus and the siphon by which it communicates with the point of reflexion of the intestine coloured red. There has consequently been an introduction of water into the intestine by this course, and a possible passage of a part of this water into the general cavity through the walls of the digestive tube. —*Comptes Rendus*, November 16, 1874, tome lxxix. pp. 1128–1132.

Embryology of the Ctenophora. By Alexander Agassiz.

The question of the systematic position of the Ctenophora can now, thanks to the greater knowledge we have of their embryology, be treated more intelligently. The position taken by Vogt, who follows Quoy in removing them from the Acalephs altogether, and associating them with the Mollusks on account of the apparent bilaterality so strongly developed in some families (*Cestum*, *Bolina*, and *Mertensia*), seems not untenable. The nature of their relations to Echinoderms, Polyps, and Acalephs, as well as the general relations of the Cœlenterata to Echinoderms, may be discussed again, especially as having an important bearing not only on the value of the Cœlenterata as a primary division of the animal kingdom, but also on the limits of the Radiata, and the possible affinities of the Sponges and Cœlenterata suggested by Häckel*. A still more important point developed from this embryology is its connexion with the *Gastræa* theory of Häckel†, for which he claims that it will supplant the type theory, and give us in its place a new system based upon the homology of the embryonic layers and of the primitive digestive cavity. Häckel attempts, in his *Gastræa* theory, to find an explanation for the natural development of species from a purely mechanical cause, and has been bold enough not only to

* E. Häckel, 'Die Kalkschwämme,' Berlin, 1872.

† E. Häckel, "Die *Gastræa*-Theorie," Jenaische Zeitschrift, ix. 1874.